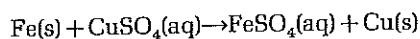


## 8.4 Heat of displacement

When iron is added to copper(II) sulphate solution the following reaction occurs:



This is known as a **displacement reaction**.

### Aim

To determine the heats of displacement for the reactions of zinc, iron and magnesium with copper(II) sulphate solution.

### Apparatus and materials

Measuring cylinder, 25 cm<sup>3</sup>

Thermometer, -10 to +110°C

Plastic cup

Copper(II) sulphate solution, 0.2 mol dm<sup>-3</sup>

Zinc powder

Iron filings

Magnesium powder

### Procedure

- 1 Use a measuring cylinder to pour 25 cm<sup>3</sup> of copper(II) sulphate solution into the plastic cup.
- 2 Measure the temperature of the copper(II) sulphate solution.
- 3 Weigh out about 0.5 g (an excess) of zinc powder.
- 4 Add the zinc powder to the copper(II) sulphate solution and stir the mixture well with the thermometer.
- 5 Record the highest temperature reached and calculate the temperature rise.
- 6 Wash out the plastic cup and repeat steps 1-5 with iron and then magnesium. In each case weigh out 0.5 g (an excess) of the metal.

### Results

Copy and complete the following tables:

#### Zinc

volume of copper(II) sulphate solution used	= 25 cm <sup>3</sup>
temperature of copper(II) sulphate solution	= °C
highest temperature reached	= °C
rise in temperature	= °C

Complete two more tables for the reaction of iron and magnesium with copper(II) sulphate solution.

Summarize your results by copying and completing the following table:

metal	temperature rise/°C
zinc	
iron	
magnesium	

### Questions

- 1 a) Why is a plastic cup rather than a glass beaker used as the reaction vessel?  
b) Why must the powder and the solution be stirred thoroughly?  
c) Why must potassium not be used in this experiment?  
d) How would the temperature rise be affected if magnesium ribbon were used instead of magnesium powder?  
e) Explain why the use of copper(II) nitrate solution, instead of copper(II) sulphate solution, would not be expected to affect the experimental results.
- 2 For every 1°C rise in temperature, 25 cm<sup>3</sup> of the copper(II) sulphate solution absorbs 105 J.  
a) Calculate the amount in moles of copper(II) sulphate in 25 cm<sup>3</sup> of 0.2 mol dm<sup>-3</sup> copper (II) sulphate solution.  
b) Calculate the energy change per mole of copper(II) sulphate per °C given the information at the start of the question.  
c) Calculate the energy changes per mole of copper(II) sulphate for the reactions with zinc, iron and magnesium. The metals are in excess and their masses are not used in the calculation. The answers to (c) will be the heats of displacement.
- 3 For each of the reactions taking place in the above experiment write two equations.  
a) A balanced equation.  
b) An ionic equation.
- 4 What is meant by:  
a) displacement  
b) the reactivity series of metals  
c) heat of displacement?